NASA Procedural Requirements

NPR 8715.3C
Effective Date: March 12, 2008
Expiration Date: March 12, 2013

COMPLIANCE IS MANDATORY

Printable Format (PDF)

Request Notification of Change (NASA Only)

Subject: NASA General Safety Program Requirements

Responsible Office: Office of Safety and Mission Assurance

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Chapter 6. Nuclear Safety for Launching of Radioactive Materials

6.1 Purpose

6.1.1 This chapter provides internal NASA procedural requirements for characterizing and reporting potential risks associated with a planned launch of radioactive materials into space, on launch vehicles and spacecraft, during normal or abnormal flight conditions. Procedures and levels of review and analysis required for nuclear launch safety approval vary with the quantity of radioactive material planned for use and potential risk to the general public and the environment.

6.1.2 An analysis or evaluation may be required in accordance with paragraph 9 of Presidential Directive/National Security Council Memorandum Number 25 (PD/NSC-25), Scientific or Technological Experiments with Possible Large-Scale Adverse Environmental Effects and Launch of Nuclear Systems into Space, dated December 14, 1977, as amended, in obtaining nuclear launch safety approval. Guidance on procedures, requirements, or licensing details for using, storing, shipping, or handling radioactive materials in ground processing facilities or activities or in preparation for space uses is not included in this chapter (see paragraph 3.16). The tracking of radiation exposures to workers is also not included in this chapter.

6.1.3 Mission Directorate Associate Administrators, Center Directors, and program executives shall ensure that NASA missions involving the launch of radioactive materials comply with the provisions of the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.), and follow the policy and procedures contained in 14 CFR Part 1216, Subpart 1216.3, Procedures for Implementing the National Environmental Policy Act (NEPA), NPR 8580.1, Implementing the National Environmental Policy Act and Executive Order 12114 (Requirement 25118).

6.2 Responsibilities

6.2.1 The NASA Administrator or designee shall:

a. Determine, for NASA, the acceptability of the potential risk of launching and using nuclear materials in space as described in Table 6.1 (Requirement 32190).

b. Request empanelment of an Interagency Nuclear Safety Review Panel (INSRP) with membership and responsibilities in accordance with PD/NSC-25 after receiving a request from the Program Executive (in coordination with SMA). (Requirement 32257).

c. Appoint a NASA member to the empanelled INSRP with consideration of the recommendations(s) by the Chief, Safety and Mission Assurance (Requirement).

6.2.2 Mission Directorate Associate Administrators, Center Directors, and program executives involved with the control and processing of radioactive materials for launch into space shall ensure:

a. Compliance with space nuclear launch safety requirements and processes provided in this NPR (Requirement 25119).

b. Basic designs of vehicles, spacecraft, and systems utilizing radioactive materials provide protection to the public, the environment, and users such that radiation risk resulting from exposures to radioactive sources are as low as reasonably achievable (Requirement).

c. Nuclear safety considerations are incorporated from the initial design stages throughout all project stages to ensure that overall mission radiological risk is acceptable (Requirement 25120).

d. All space flight equipment (including medical and other experimental devices) that contain or use radioactive materials are identified and analyzed (per paragraph 6.3 of this NPR) for radiological risk (Requirement 25121).

e. Development of site-specific ground operations and radiological contingency plans commensurate with the risk represented by the planned launch of nuclear materials (Requirement 25122).

f. Contingency planning, as required by the National Response Plan, includes provisions for emergency response and support for source recovery efforts (Requirement 32191).

Note: NPD 8710.1, Emergency Preparedness Program, and NPR 8715.2, NASA Emergency Preparedness Plan Procedural Requirements, address the NASA emergency preparedness policy and program requirements.

g. Involve the OCHMO in the Federal Radiological Emergency Response planning process (Requirement).

6.2.3 The Chief, Safety and Mission Assurance, shall:

a. Assure that NASA missions involving the launch of radioactive materials comply with paragraph 9 of PD/NSC-25, as appropriate (Requirement 32192).

b. Assist in the review and evaluation of nuclear safety risk (Requirement 32193).

c. Per Table 6.1, prepare, coordinate, and provide the required notification of planned launches of radioactive materials to the Executive Office of the President, Office of Science and Technology Policy (OSTP) (Requirement 32196).

d. Designate a Nuclear Flight Safety Assurance Manager (NFSAM) (Requirement).

e. Designate a NASA INSRP Coordinator (Requirement).

f. Nominate a NASA member for each empanelled ad hoc INSRP following a request by the program or mission office to the NASA Administrator (Requirement).

Note: The NFSAM and NASA INSRP Coordinator may be separate individuals.

g. Provide assistance to the cognizant NASA Mission Directorate and project office(s) in meeting nuclear launch safety analysis/evaluation requirements (Requirement 32197).

h. Review all radiological contingency and emergency planning as part of the SMA audits, reviews, and assessments process. (Requirement).

Note: The requirements for conducting and supporting these reviews are provided in NPR 8705.6, Safety and Mission Assurance Audits, Reviews, and Assessments.

i. Ensure that the OCHMO is notified of the intent to launch radioactive materials (Requirement).

j. Coordinate health physics aspects with the OCHMO periodically and in the event of any related radiological emergencies during the mission (Requirement).

6.2.4 Mission Directorate Associate Administrators and program executives shall:

a. Designate an individual responsible for ensuring the implementation of the requirements for nuclear launch safety approval in accordance with paragraph 9 of PD/NSC-25 (Requirement 32200).

b. Notify the NASA Headquarters NFSAM in writing as soon as radioactive sources are identified for potential use on NASA spacecraft to schedule nuclear launch safety approval activities (Requirement 32201).

c. Identify the amount of radioactive material and the process for documenting the risk represented by the use of radioactive materials to the NFSAM in accordance with paragraph 6.4 of this NPR (Requirement).

d. Provide required reports to the NFSAM in accordance with paragraphs 6.3 and 6.4 of this NPR (Requirement 32202).

e. Prepare or have prepared the nuclear safety analyses (Requirement).

f. Obtain nuclear launch safety approval or launch concurrence in accordance with paragraph 6.3 of this NPR (Requirement 32203).

6.2.5 Mission Directorate Associate Administrators, Center Directors, and line managers shall:

a. Ensure, to the extent of responsibility applicable under defined licensing/permitting documentation or agreements, compliance with all pertinent directives, licenses, agreements, and requirements promulgated by regulatory agencies relative to the use of radioactive materials planned for a space launch (Requirement 32204).

b. Coordinate with appropriate project office(s) to ensure radioactive material source reports that are submitted per paragraph 6.4 of this NPR accurately reflect all known radioactive material sources intended for flight (Requirement 32205).

6.2.6 NASA launch and landing site managers shall:

a. Apply range safety requirements, with regard to the safe launch of radioactive materials, specified in range safety standards (Requirement 25123).

Note: Requirements for range safety concerning the launch of radioactive material are given in the Air Force Space Command Manual 91-710, Volume 2, Safety, Range Safety User Requirements Manual Volume 2 - Flight Safety Requirements (1 July 2004).

b. Develop and implement site-specific ground operations and radiological contingency plans to address potential ground handling accidents and potential launch/landing accident scenarios and to support source recovery operations commensurate with the radioactive materials present (Requirement 32207).

Note: Requirements for contingency plans are provided in NPR 8715.2, NASA Emergency Preparedness Plan Procedural Requirements.

c. Coordinate radiological contingency plans and exercises with the OCHMO (Requirement).

d. Exercise contingency response capabilities as deemed necessary to ensure adequate readiness of participants and adequacy of planning to protect the public, site personnel, and facilities (Requirement 32208).

e. Ensure appropriate and timely coordination with regional Federal, State, territorial, and local emergency management authorities to provide for support to, and coordination with, offsite emergency response elements (Requirement 32209).

f. Make provisions for special offsite monitoring and assistance in recovery of radioactive materials that could spread into areas outside the geographical boundaries of the launch site (Requirement 32210).

g. Establish a radiological control center (RADCC) for launches and landings with radioactive sources possessing a significant health or environmental risk, or having an activity of A2 mission multiple greater than 1,000 as determined per paragraph 6.3 of this NPR, or as specified in applicable interagency agreements (Requirement 32211).

h. Ensure, when required, that the RADCC provides technical support and coordination with other Federal, State, territorial, and local agencies in the case of a launch or landing accident that may result in the release of radioactive materials (Requirement).

i. Ensure, when required, that the RADCC is operational during launch and landing phases anytime there is a potential for an accident that could release radioactive material (Requirement 32213).

j. Ensure, when required, that the RADCC is staffed commensurate with the risk associated with the radioactive materials present (Requirement 32212).

6.2.7 The NASA INSRP Coordinator shall:

a. Coordinate NASA's participation in activities supporting empanelled INSRP(s) to ensure adequate information is available to the INSRP(s) (Requirement 32214).

b. Make arrangements for NASA personnel to provide technical assistance to empanelled INSRP(s) (Requirement 32215).

c. Coordinate the support needs of those selected to provide assistance to empanelled INSRP(s) as may be appropriate (i.e.; travel, funding, technical) (Requirement 32216).

d. Coordinate health physics aspects with the OCHMO (Requirement).

6.2.8 The NASA member of an empanelled INSRP shall:

a. Represent NASA in accordance with PD/NSC-25 (Requirement).

b. Provide technical liaison between the empanelled INSRP and NASA management (Requirement).

6.2.9 The Office of Security and Program Protection shall:

a. Ensure appropriate coordination with the Department of Homeland Security (Federal Emergency Management Agency) to provide adequate emergency and recovery planning for all NASA missions above a threshold of 1,000 for A2 mission multiple as defined in paragraph 6.3 of this NPR (Requirement 32194).

b. Ensure that radiological emergency and recovery plans are developed and implemented where NASA is the Lead Federal Agency as defined by the National Response Plan - Nuclear/Radiological Incident Annex (Requirement 32195).

c. Upon request, provide the program executive and OSMA with mission-specific information recommended for consideration during launch or potential accident site emergency response and clean-up planning as part of the nuclear launch approval process (Requirement).

6.3 Nuclear Launch Safety Approval Process

The level of analysis, evaluation, review, and the concurrence or approval required for a radiological risk assessment varies with the total amount of radioactive materials planned for launch as follows:

6.3.1 For all planned launches of radioactive materials, program executives shall:

a. Use the A2 mission multiple value to determine the level of assessment required (Requirement 32217).

b. Use total mission radioactive material inventory contained on the launch to calculate the total A2 mission multiple per Appendix D, Activity and Radioactivity Limits - Basic A1/A2 Values (Requirement 32222).

c. Use the highest of the algebraic sum of the isotopes' A2 multiples at launch, anytime the spacecraft will be in Earth orbit, or during near Earth interplanetary flight (e.g., Earth Gravity Assists) to determine the level of assessment required (Requirement 322
Requirement 32223).

d. Consult with the NFSAM and the NASA Office of the General Counsel to determine what provisions, if any, of this chapter apply when NASA participates in the launch of a vehicle or spacecraft from other countries or territories, and these vehicles or spacecraft contain a radioactive source (Requirement 32221).

6.3.2 Internal NASA Nuclear Launch Safety Process.

A summary of the nuclear launch safety review, reporting, and approval requirements is provided in Table 6.1, Nuclear Launch Safety Approval Summary.

A_2 Mission Multiple	Launch Reported to NFSAM	Launch Concurrence/ Approval by	Launch Reported to OSTP	Required Level of Review and Reports	Approval/ Concurrence
$A_2 < 0.001$	Yes	NFSAM	no	Paragraph 6.3.3	Concurrence letter from NFSAM
$0.001 \leq A_2 < 10$	Yes	NFSAM	yes	Paragraph 6.3.4	Concurrence letter from NFSAM
$10 \leq A_2 < 500$	Yes	Chief, Safety and Mission Assurance	yes	Paragraph 6.3.5, Nuclear Safety Review	Approval letter from Chief, Safety and Mission Assurance
$500 \leq A_2 < 1{,}000$	Yes	NASA Administrator	yes	Paragraph 6.3.6, Safety Analysis Summary (SAS)	Approval letter from NASA Administrator
$1000 \leq A_2$	Yes	Executive Office of the President	yes	Paragraph 6.3.7, Safety Analysis Report	NASA Administrator requests approval via Director, OSTP

Table 6.1 Nuclear Launch Safety Approval Summary

6.3.3 For launches with A2 mission multiples less than 0.001:

6.3.3.1 Program executives (in addition to requirements in paragraph 6.2 of this NPR) shall:

a. Request nuclear launch safety concurrence in writing from the NFSAM (Requirement 25132).

b. Submit the request to the NFSAM a minimum of 4 months prior to launch (Requirement).

Note: The request should be accompanied by the Radioactive Materials On-Board Report defined in paragraph 6.4.1 of this NPR.

6.3.3.2 The NFSAM shall review the report and inform the program executive in writing of concurrence (or nonconcurrence) and any safety concerns not less than 2 months prior to launch (Requirement 32227).

6.3.4 For launches with A2 mission multiples between 0.001 and 10:

6.3.4.1 Program executives (in addition to requirements in paragraph 6.2 of this NPR) shall:

a. Request nuclear launch safety concurrence in writing from the NFSAM (Requirement 25133).

b. Submit the request to the NFSAM a minimum of 4 months prior to launch (Requirement).

Note: The request should be accompanied by the Radioactive On-Board Materials Report defined in paragraph 6.4 with a brief technical description of the radioactive material.

6.3.4.2 The NFSAM shall:

a. Review the request and inform the program executive in writing of nuclear launch safety concurrence (or nonconcurrence) and any safety concerns not less than 2 months prior to launch (Requirement).

b. Report launches with these quantities of radioactive material to the OSTP prior to launch (Requirement 32228).

6.3.5 For launches with A2 mission multiples equal to or greater than 10 but less than 500:

6.3.5.1 Program executives (in addition to requirements in paragraph 6.2 of this NPR) shall:

a. Develop and document, in consultation with the NFSAM, a mutually agreed upon schedule for developing a nuclear safety review (Requirement).

b. Prepare or have prepared a nuclear safety review of the radiological risk for the proposed mission (Requirement 32232).

c. Ensure that the nuclear safety review contains the report described in paragraph 6.4 of this NPR (Requirement 32233).

d. Ensure that the nuclear safety review contains program excerpts describing the mission (Requirement 32234).

e. Ensure that the nuclear safety review contains an analysis of the probabilities of launch and in-flight accidents which could result in the terrestrial release of radioactive materials (surface and air) (Requirement 32235).

f. Ensure that the nuclear safety review contains an estimate of the upper bound of health and environmental effects due to a radioactive material release (Requirement 32236).

g. Ensure that the nuclear safety review contains mission-specific information recommended for consideration in the launch or potential accident site emergency response and clean-up planning (Requirement 32237).

h. Provide the Chief, Safety and Mission Assurance, and the NFSAM the nuclear safety review along with a request for nuclear launch concurrence at least 5 months prior to launch (Requirement 32238).

6.3.5.2 The NFSAM shall:

a. Make a preliminary scoping evaluation of the radiological risk to identify the extent of analyses needed as part of a prelaunch nuclear safety review (Requirement 32230).

b. Develop and document, in consultation with the program executive, a mutually agreed upon schedule for developing a nuclear safety review (Requirement 32231).

c. Notify OSTP of the planned launch with these quantities of radioactive material as a part of the quarterly report (Requirement 3223 Requirement 32239).

6.3.6 For launches with A2 mission multiples equal to or greater than 500 but less than 1,000:

6.3.6.1 Program executives (in addition to requirements in paragraph 6.2 of this NPR) shall:

a. Develop and document, in consultation with the NFSAM, a mutually agreed upon schedule for developing a nuclear safety review (Requirement).

b. Prepare or have prepared a Safety Analysis Summary (SAS) that, in coordination with the NFSAM, addresses the radiological risk of the proposed mission (Requirement 32244).

> *Note: The level of detail in the SAS will be commensurate with the radiological risk. The program is encouraged to use other program documentation to provide mission and potential accident information in the SAS.*

c. Ensure that the SAS contains a brief description of the planned mission, schedule, launch vehicle, and spacecraft to include operations while in-orbit and during near-Earth flight (Requirement 32245).

d. Ensure that the SAS contains a description of all radioactive materials, their physical state/chemical form, and quantities (Requirement 32246).

e. Ensure that the SAS contains probabilities and resulting consequences of launch and in-flight accidents that could result in the terrestrial release of radiological materials (Requirement 32247).

f. Ensure that the SAS contains an estimate of any health and environmental effects due to a radioactive material release (Requirement 32248).

g. Ensure that the SAS contains mission-specific information recommended for consideration in the launch or potential accident site emergency response and clean-up planning (Requirement 32249).

h. Provide the Chief, Safety and Mission Assurance, the SAS along with a request for nuclear launch concurrence at least 6 months prior to launch (Requirement).

i. Provide the OCHMO the SAS at least 6 months prior to launch (Requirement).

j. Forward the SAS to the NASA Administrator, along with the concurrence of the Chief, Safety and Mission Assurance, no later than 4 months before launch and request nuclear launch safety approval from the NASA Administrator (Requirement 32251).

6.3.6.2 The NFSAM shall:

a. Make a preliminary assessment of the radiological risk and provide a written assessment to the program executive (Requirement 32242).

b. Develop and document, in consultation with the program executive, a mutually agreed upon schedule for nuclear launch safety analyses and review activities to be conducted to support a nuclear launch safety concurrence request (Requirement 32243).

c. Review the SAS and provide timely comments to the program in accordance with the mutually agreed upon schedule (Requiremer Requirement 32250).

d. Notify OSTP of the planned launch as a part of the quarterly report (Requirement 32252).

6.3.7 For launches with A2 mission multiples equal to or greater than 1000:

6.3.7.1 Program executives (in addition to requirements in paragraph 6.2 of this NPR) shall:

a. Request, in coordination with the Chief, Safety and Mission Assurance, the NASA Administrator to empanel an ad hoc INSRP for the mission (Requirement 32255).

b. Factor the time required for an INSRP into the program master schedule (Requirement 32256).

c. Develop and document, in consultation with the NFSAM, the empanelled INSRP, the program, and the appropriate Department of Energy (DOE) offices (in accordance with interagency agreements for specific missions), a schedule for the delivery of a Safety Analysis Report (SAR), using a phased approach, with the complete final SAR being delivered no later than 10 months prior to launch (Requirement 32260).

Note: The mutually agreed upon schedule should address the planned analysis schedule, base assumptions, analysis limitations/bounds, and model descriptions associated with the SAR development. Interim reviews should be held for all individual analyses before completion and to provide a status of analyses as of a given date.

d. Prepare or have prepared a SAR (Requirement 32258).

Note: The level of detail and content of the SAR will be commensurate with the mission radiological risk. In cases where the DOE provides the radioactive material, the DOE programmatic SAR may be adopted to satisfy this requirement, in accordance with the interagency agreement(s) for specific missions. In cases where launch vehicles, configuration, and radioactive materials are similar, the program executive, in consultation with the NFSAM and the INSRP, is encouraged to use a comparative analysis based upon previous mission(s) safety analyses that bound the anticipated risk for the new mission. Where radioactive materials are being provided from multiple sources, the program executive may provide a single or multiple SAR document(s) to best meet this requirement. The program executive is encouraged to begin coordination with the empanelled ad hoc INSRP in the early stages of mission development. The program executive should invite the INSRP to review the development of launch and mission accident scenarios, probabilities of occurrence, dispersion, specification of associated environments, and health effects via documentation and program safety reviews. The INSRP normally reviews and evaluates all program documentation associated with radioactive material safety for completeness and defensibility. The INSRP evaluation is documented in a Safety Evaluation Report (SER). The INSRP is normally assisted in its evaluation effort by expert consultants in various specialized areas from a number of Government agencies, national laboratories, industry, and academia.

e. Deliver the agreed iterations of the SAR to the INSRP according to the documented schedule (Requirement).

6.3.7.2 Following the approval by the NASA Administrator to empanel an INSRP, the NASA INSRP Coordinator shall, in accordance with paragraph 6.2.7, facilitate the preparation of an INSRP-developed SER of the radiological risk for the proposed nuclear mission as required by PD/NSC-25 (Requirement 32261).

Note: The SER should typically be completed no later than 6 months prior to launch. The SER, along with the final SAR and other related documents, are considered by the NASA Administrator before requesting nuclear launch safety approval in accordance with PD/NSC-25.

6.3.8 For orbiting spacecraft being resupplied or modified in which the U.S. Government is the lead (e.g., International Space Station) and the A2 mission multiple is equal to 10 but less than 1000:

6.3.8.1 Program executives shall:

a. Request a nuclear launch safety approval from the NFSAM (Requirement 25137).

b. Perform a safety analysis to the level of detail defined in paragraph 6.3.6 of this NPR (Requirement 32262).

c. Meet the launch concurrence/approval requirements defined in paragraph 6.3.6 of this NPR (Requirement).

6.3.8.2 The NFSAM shall conduct reviews as defined in paragraph 6.3.6 of this NPR (Requirement).

6.3.9 For orbiting spacecraft being resupplied or modified in which the U.S. Government is the lead (e.g., International Space Station) and the A2 mission multiple exceeds 1000:

6.3.9.1 Program executives shall:

a. Request a nuclear launch safety approval from the NFSAM (Requirement).

b. Perform a safety analysis to the level of detail defined in paragraph 6.3.7 of this NPR (Requirement).

c. Meet the launch concurrence/approval requirements defined in paragraph 6.3.7 of this NPR (Requirement).

6.3.9.2 The NFSAM shall:

a. Advise the program executive concerning a request to the NASA Administrator to empanel an INSRP as per paragraph 6.2.2 of this NPR.

b. Coordinate a safety evaluation as defined in paragraph 6.3.7.1 of this NPR (Requirement).

6.4 Report Requirements

6.4.1 Nuclear launch safety analyses (e.g., SAS, SAR) and evaluation (e.g., SER) are described in previous paragraphs.

6.4.2 Radioactive Materials Report

6.4.2.1 NASA program executives, Center Directors, facility managers, laboratory managers, and launch and landing site managers shall:

a. Use the Radioactive Materials On-Board Report shown in Figure 6.2 to report planned launches of radioactive materials and request for nuclear launch concurrence/approval (Requirement 32265).

b. Ensure that entries are made for each isotopic source for planned launch and resupplying missions (Requirement 32267).

Note: Isotopes of similar size, chemical form, and activity level may be combined on a single line entry.

6.4.2.2 The NFSAM shall use the format of the Radioactive Materials On-Board Report shown in Figure 6.2 for the quarterly report to notify OSTP of planned launches (Requirement 32266).

Note: Figure 6.2 shows the format for the reports for planned launch and for resupplying radioactive materials to on-orbit

spacecraft.

Isotope	Date Arrived On-Board	Number of Sources	Total Activity at Arrival (Ci)	Isotope Half-life	Activity as of Mission Start (Ci)	A2 Limit for Isotope (Ci)	Current A2 Multiple for Each Isotope Source	Remarks
	(Use one line for each isotope type, size, form, and arrival date)							
	(Use one line to sum the A2 mission multiples for the spacecraft)							

Figure 6.2 Radioactive Materials On-Board Report

Note: The Activity and Radioactive Material Limits table is located in Appendix D.

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